S I M

Space Interferometry Mission

SIM PROJECT
PRELIMINARY INSTRUMENT SYSTEM REQUIREMENTS REVIEW
(PISRR)

Introduction

17-18 March, 1998

James C. Marr-IV

Instrument System Manager

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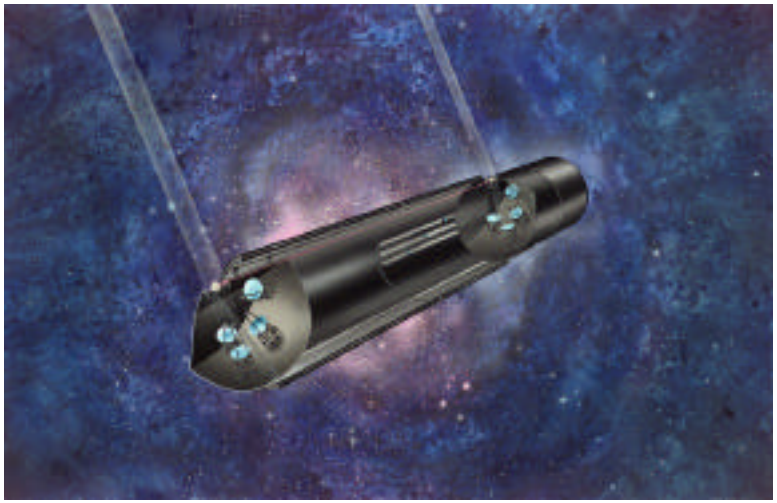
PROJECT OVERVIEW



Objectives:

- High precision astrometry (implements Bahcall Report recommendations)
- Synthetic aperture imaging
- Technology precursor to Planet Finder

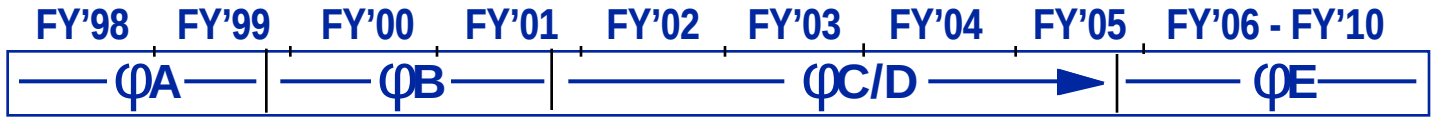
Target Cost:

- < 480M $Real Year for Phase C/D

Key Features:

- 4 interferometers on a 10 meter baseline in Earth Trailing orbit.
- Astrometry
  - Global : 4 micro-arcsecond - 20th magnitude object
  - Narrow-angle: 1 micro-arcsecond - 15th magnitude object
- 10 milli-arcsecond synthesis imaging
- 10^{-4} depth achromatic stellar nulling

Schedule



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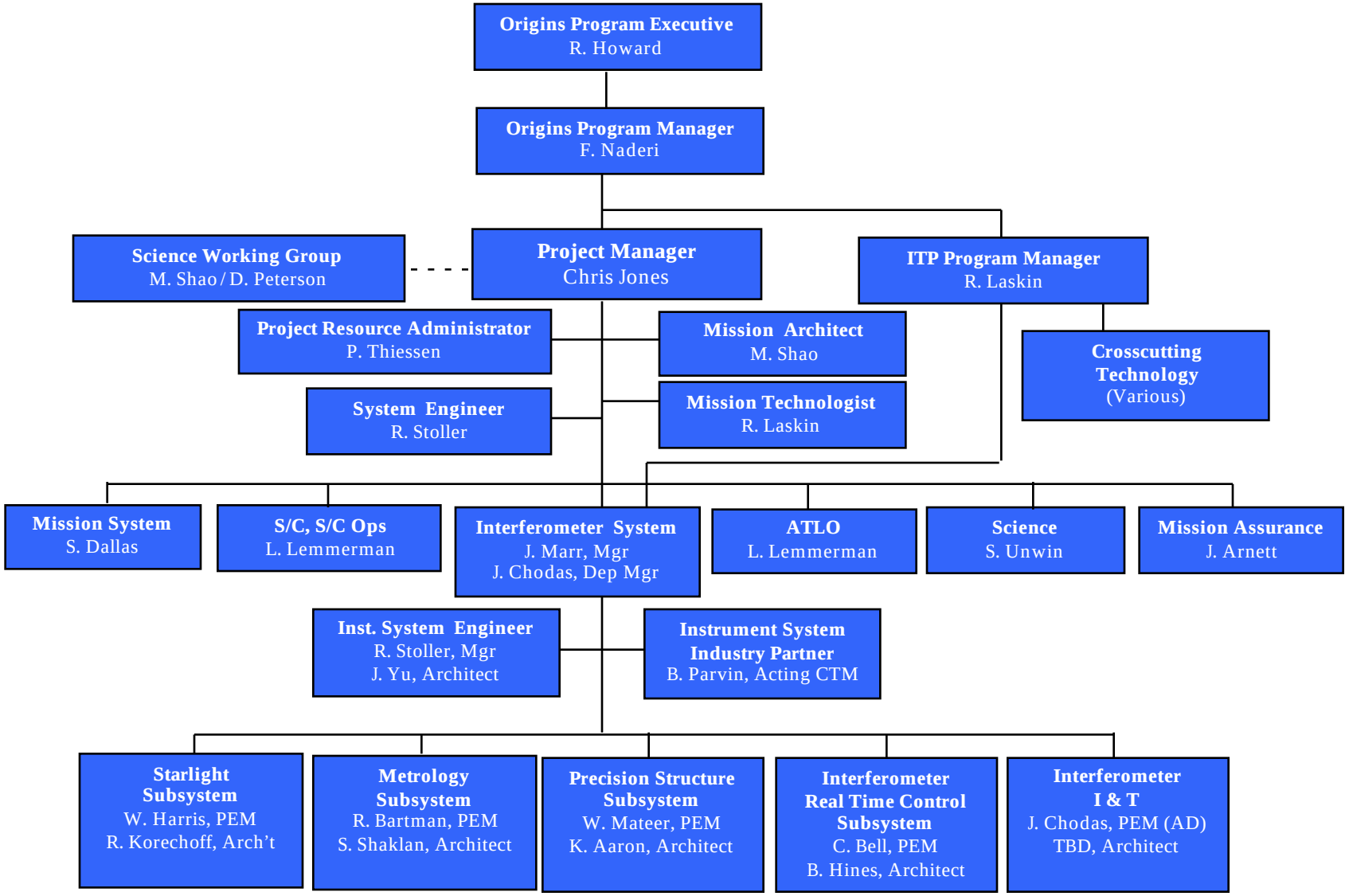
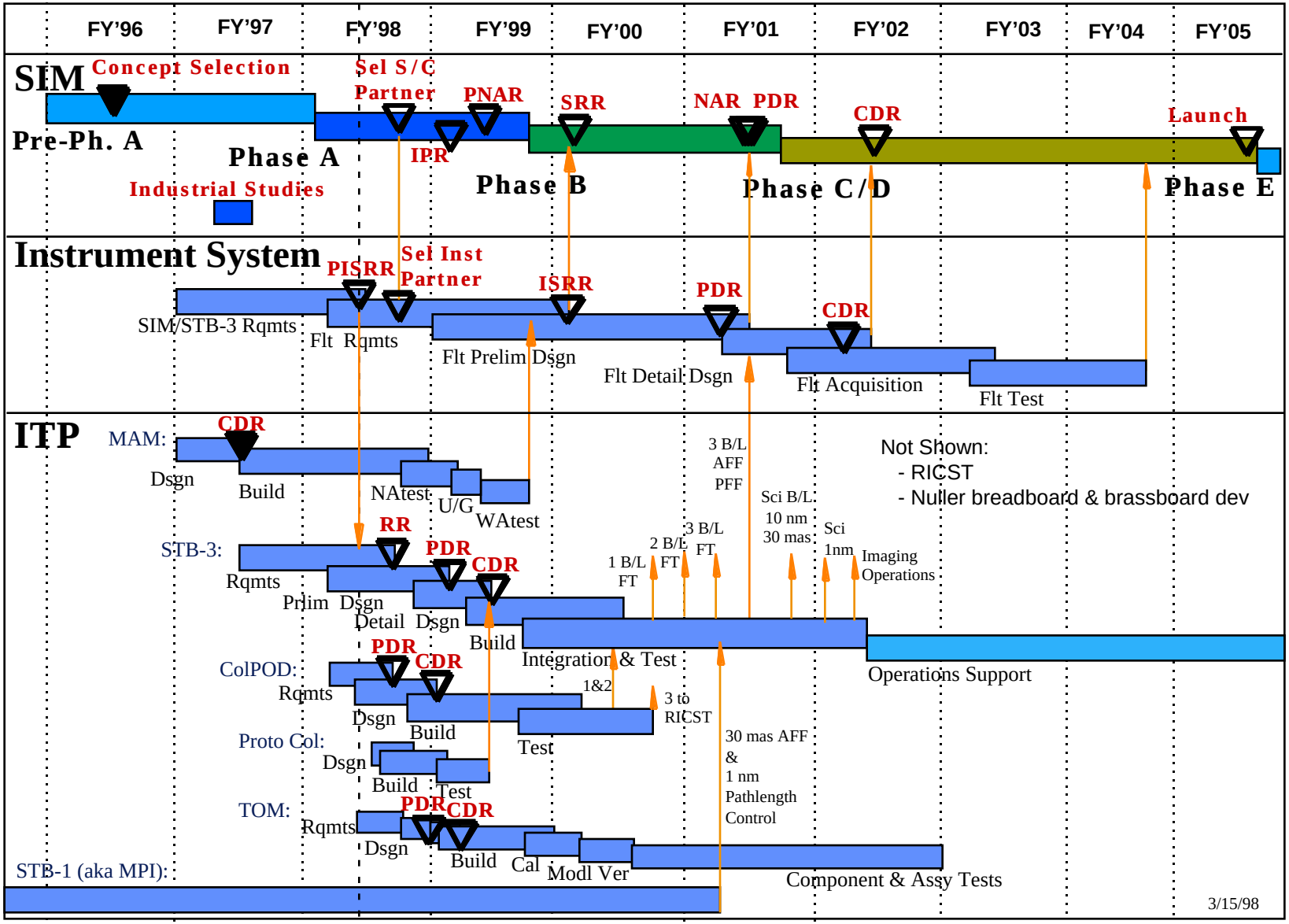
PROJECT ORGANIZATION



SUMMARY SCHEDULE



SIM

Space Interferometry Mission

RECENT CHANGES

- Orbit changed from 900 km LEO to SIRTF-like Earth Trailing (ET).
- SIM instrument architecture trade review held 1st week of Feb '98.
  - SOS architecture selected over previous "Classic" architecture.
  - Only two significant distinguishers found:
    - > Much simpler metrology system in SOS architecture (+).
    - > Adopting SOS architecture would require a change in direction in testbed development (-).
- Only 6 weeks have elapsed since the trade decision was made.
  - Team has been focused on requirements flowdown for today's review.
  - Implementation planning is still not complete.
    - > Especially true where architecture change significantly impacted certain testbeds.
    - > Expect to work these impacts over the next three months.

TESTBED CHANGES

- Pervious Plan
  - 3D Metrology → Breadboard, vacuum
  - MAM → 1/5 scale, 1 BL, vacuum
  - STB1 (aka MPI) → 1 BL breadboard, air
  - STB2 (x) → 2 BL breadboard, air
  - STB3 → 3 BL “brassboard”, air
  - Super-Zygo → TBD
  - RICST
  - Component testbeds

- New Plan
  - 1D Metrology → Breadboard, vacuum
  - MAM → 1/5 scale, 1 BL, vacuum
  - STB1 (aka MPI) → 1 BL breadboard, air
  - → Collector Angle Feed Fwd
  - Proto Collector → 1-collector, air
  - Collector POD → 3-collector POD, air
  - STB3 → 3 BL “brassboard”, air
  - Thermo-Opto-Mechanical → Super-Zygo facility, vacuum
  - RICST + CAT
  - Component testbeds

INDUSTRY PARTNERING

- Three industry teams, selected via competitive procurement, have been participating in the SIM design efforts since December 1996.
  - Ball Aerospace (lead), Boeing, Smithsonian Astrophysical Observatory, University of Colorado
  - Lockheed Martin (Sunnyvale) (lead), Honeywell
  - TRW (lead), Raytheon Optical Systems (formerly HDOS), Kodak, Science Consultants
- Current industry partnering plans are to have two work packages, for which we will have one or two industry partners(s), to work with JPL to continue SIM development and operations through EOM:
  - Instrument Work Package (IWP) - (est $125M)
    - Contractor to be selected by 1 July 1998 (goal) to assist, under JPL lead, in the definition, design, development and operation of the SIM Instrument System.
  - Spacecraft-ATLO Work Package (SWP) - (est $140M)
    - Contractor to be selected by 1 July 1998 (goal) to assist, under S/C-ATLO Industry Partner (SIP) lead, in definition, design, development and operation of the overall structure (?), the spacecraft engineering systems, and ATLO.

SIM LIFE CYCLE COST ($M Real Year)

	Fiscal Year														Real Year
	97	98	99	00	01	02	03	04	05	06	07	08	09	10	Total
Pre-Phase A	4.0														4.0
Phase A/B		14.8	15.0	27.2	27.0										84.0
Phase C/D					51.0	105.5	129.8	103.4	91.3						481.0
Phase E									14.5	30.9	32.2	33.0	33.9	17.4	161.9
ITP	9.0	21.0	16.0	13.5											59.5
JPL Total	13.0	35.8	31.0	40.7	78.0	105.5	129.8	103.4	105.8	30.9	32.2	33.0	33.9	17.4	790.4
NASA SubTotal	13.3	36.7	31.8	41.7	80.0	108.1	133.0	106.0	108.4	31.7	33.0	33.8	34.7	17.8	810.2
Launch Vehicle							17.1	32.2	22.8						72.1
NASA Total	13.3	36.7	31.8	41.7	80.0	108.1	150.1	138.2	131.2	31.7	33.0	33.8	34.7	17.8	882.3

- Recent change in launch vehicle to support ET orbit is not shown above.
  - Current HQ direction is that life cycle cost is to remain unaffected.
  - The new baseline Delta III is roughly $35M more expensive than the Delta II 7925 shown.
  - An EELV option may come in somewhere within the cost range shown for the Delta II.

TECHNOLOGY DEVELOPMENT PHILOSOPHY

- Must have confidence, prior to NAR/PDR, that all key SIM requirements can be met.
  - Where this requires a technology testbed, tests must be completed prior to flight system NAR/PDR if possible, prior to flight system CDR essential.
- Use the simplest method possible to demonstrate each key requirement for SIM as early in the development cycle as possible.
- Technology development for SIM accomplished under the leadership of the same team which is or will be doing the flight instrument development.

KEY SIM TECHNOLOGIES

- **Nanometer** control and stabilization of optical elements on a lightweight flexible structure
- **Subnanometer** sensing of optical-element-relative positions over 10 meters of separation distance.
- Overall **Instrument complexity** and the implication for Interferometer I&T and autonomous on-orbit operation
  - Over 40 **Opto-Mechanical Components**
  - Over 100 **Actuators & Real Time Control Loops**

REVIEW OBJECTIVES

- To review:
  - The SIM Instrument System requirements flowdown process.
    - > Does our flowdown process make sense?
  - The preliminary results of that requirements flowdown.
    - > for the SIM instrument
    - > for the SIM technology testbeds

- Review focus is requirements, NOT how to achieve them.
  - Please make this distinction in your minds. Think requirements (on flight, on testbeds), NOT how to demonstrate or achieve those requirements.
  - You will hear some implementation concepts, especially for testbeds, for illustrative purposes only. This is not the focus of the review.

SCOPE

- SIM Instrument System and related technology demonstration testbeds.

- Level-3 to level-4 key requirements flowdown.
  - Functional performance requirements only.
    - > Most testbeds will have their own individual RR's later.
    - > Full SIM SRR not until November 2000!
  - Showing flowdown from Science Requirement Document (SRD) and TPF technology demonstration requirements.
    - > "the instrument shall..."
    - > "the starlight subsystem shall..."
  - Some level-5 flowdown has been done, and will be shown, but is not as complete.

- Reference designs used in flowing down requirements.

REVIEW BOARD

- Rick Howard (NASA HQ)
- Firouz Naderi (JPL Origins)
- Mark Colavita (Keck)

- SIMSWG members:
  - Mike Shao (JPL, SWG co-chair)
  - Deane Peterson (SUNY, SWG co-chair)
  - Ken Seidelmann (USNO, chair: A&SSD Subcommittee)

- SIM TAC members:
  - Clint Dutcher (Int'd Sciences)
  - Bob O'Donnel (MRJ, Inc , PISRR CHAIR)

- Other members of the SIM SRB:
  - Mark Saunders (LaRC)
  - Duncan MacPherson
  - Tom Gavin (JPL)

- Gary Coyle (JPL)
- Tom Fraschetti (JPL)
- Dave Linick (JPL)

CHARGE TO BOARD

- Does our requirements flowdown process make sense?
  - Identify inadequacies.
  - Recommend improvements.
- Does the team adequately understand the Instrument System level three key functional performance requirements?
  - Identify areas where improvement is needed.
- Are the requirements to be demonstrated in the various testbeds adequately understood?
  - Are the requirements to be demonstrated in the testbeds clear?
    - > What is not clear or missing?
  - Do we have the correct suite of testbeds for the requirements to be demonstrated?
    - > What changes should be made?

AGENDA - DAY 1

0830	Welcome	Jones / Naderi
0840	Introduction	Marr
0910	SIM Requirements	Unwin
0940	SIM Project System	Stoller
SIM Systems:		
1025	Mission System	Dallas
1045	Spacecraft System	Kobele
1055	Pointing	Lee
Instrument:		
1105	Functional Overview	Kahn
1135	Lunch	
1300	Requirements and Flowdown of Error Budgets	Yu
1400	Dynamics & Control Requirements and Flowdown	Laskin
Instrument Subsystems:		
1500	Starlight (STL)	Korechoff
1530	Metrology (MET)	Bartman / Chan
1600	Real Time Control (RTC)	Bell
	Controls	Chu
	Software	Brady / Hines
	Hardware Electronics	Strauss / Brady
1630	Precision Structure (PSS)	Mateer / Aaron
1700	End Day 1	

AGENDA - DAY 2

0830	Instrument Integration and Test (II&T)	Chodas
0900	Integrated Modeling (IM)	Sievers / Milman
	Testbeds:	
0930	SIM Testbed-3 (STB3)	Laskin
1030	RICST	Bell
1100	SIM Testbed-1 (STB1)	Neat
1115	Collector POD	Calvet
1145	Lunch Break	
1300	Thermo-Opto-Mechanical (TOM)	Chan
1330	Micro Arcsecond Metrology (MAM)	Shaklan
1400	1-D Laser Metrology	Bartman
1415	MET Components	Bartman / Chan
1430	STL Components	Harris
1445	Mechanical Components	Mateer
1500	Summary and Conclusion	Marr
1510	Board Discussion	All
1610	End of Day 2	

SIM

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